THE POTENTIAL OF AGROFORESTRY FOR CONSERVATION BIOLOGICAL CONTROL BY CARABIDS

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Introduction

Temperate agroforestry systems offer a great potential for the control of pests by their natural enemies, but we still do not understand how the spatial arrangement of crops, tree rows and herbaceous strips and their management affect the processes involved in conservation biological control. In particular, alley cropping systems present a regular arrangement of herbaceous strips at the bottom of the trees that are often unexploited. They provide a potentially very beneficial habitat to predatory arthropod communities that can be used to favor biological control.
Carabid species are likely to make a differential use of their habitat, for example by using strips as a refuge and reproductive habitat, whereas using crops as a habitat for foraging. The way predators use space conditions their efficiency at capturing preys and has thus direct implications for dynamics at the population level and biological control. Therefore, the question as to how the spatial arrangement of agroforestry fields affects the utilization of space by individual predators is key information towards a better understanding of biological control. Another question that directly follows is how one should manage those strips? Is it better to leave the vegetation to grow, to mow it, or manipulate it another way? The guidelines available for agroforestry management are so far silent about these questions.
The work presented here aimed at characterizing how the spatial arrangement of agroforestry systems, and in particular the presence of the herbaceous strip and its management, affects the state-dependent dynamics of space use of the carabid beetle species *Poecilus kugelanni*.

Material and methods

We assessed how the presence of herbaceous strips and their management affected the spatial distribution of the carabid beetle P. kugelanni by using a tightly-spaced pitfall trap design. Traps were sampled every two hours over a 10 day period. Vegetation in the strip was either left to grow or strips were used for storage of ramial chipped wood (RCW). The experiment was performed in an agroforestry plot and a control plot, with herbaceous strips, but no tree. The high spatial and temporal resolution of the design made it possible to characterize the variation in activity-density induced by the daily movements of individual between crops and strips. We also attempted to explain how individual decisions relating to space use was related to their energetic requirements by quantifying their nutrient reserves (lipids, carbohydrates and proteins) using colorimetric methods.

Results

The spatial arrangement of alley cropping systems affected the spatial distribution of *P. kugelanni* as there were more beetles in herbaceous strips than in adjacent crops (**Figure 1**). Beetle activity density was significantly higher in strips than in cultures in both the control plot and the agroforestry plot with herbaceous strips. This suggests that the positive effect of the strips on the activity-density of beetles can be ascribed to the presence of the herbaceous strips per se and not the trees. Moreover, strip management had a large impact on the activity-density of carabid beetles. Almost no beetles were found in RCW strips, whereas activity-density was unaffected by strip management in adjacent crops
We did not detect any difference in individual energetic reserves, as a function of habitat (strip vs culture) or as a function of strip management. These lack of differences can be explained by frequent movements between strips and crops, as revealed by a spatio-temporal analysis of activity-density at the within day scale.
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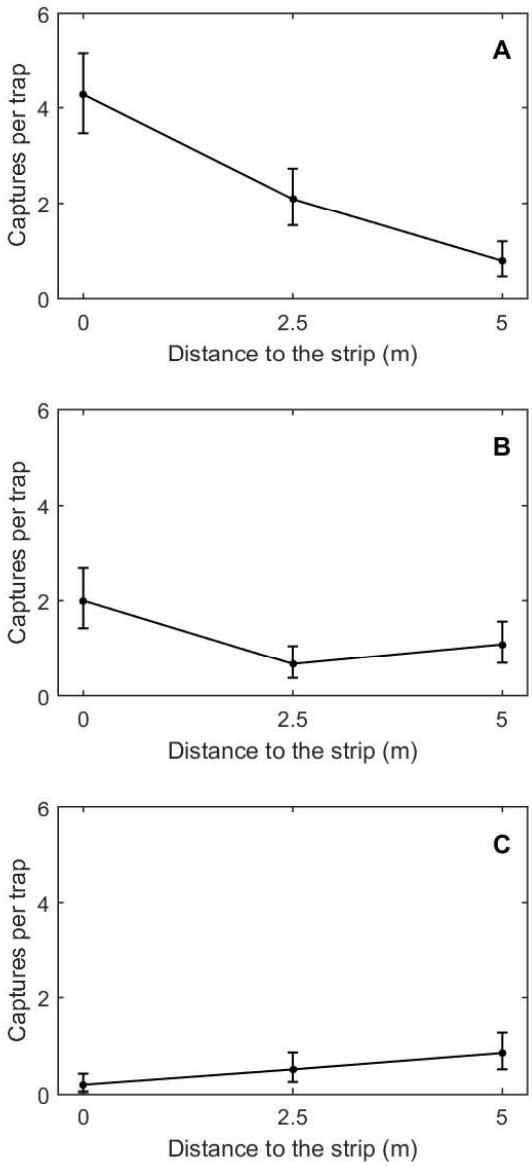

Figure 1: Number of catches per trap over the duration of the experiment as a function of the distance to the strip. A: control plot with only herbaceous strips. B: agroforestry plot (herbaceous strips plus trees). C: agroforestry plots with RCW strips.

Discussion

Overall these results point out that beetles make a dynamic use of the different habitats offered in agroforestry systems. They are sensitive to differences in the habitats present in alley cropping systems, strips and crops, and to the management of the strips, which affects their foraging behaviour. It is well recognized that even subtle differences in the foraging strategies of predators can have substantial consequences on the resulting dynamics at the population levels. Thus, our results highlight that accommodating field design and management practices carry a great potential for improving conservation biological control. In addition, the similarity of our results with other works on field margins and beetle banks, which are much more studied, implies that the rich knowledge drawn from these lines of research may be transferred to agroforestry systems.